Air Source Heat Pump Installation & Performance

Are you interested in Air Source Heat Pumps (ASHPs), but concerned about their ability to heat your home, potential running costs and noise? Find out about the latest evidence from a large scale (742 homes) study of UK heat pump installations.

## Further Information

The Electrification of Heat UK Demonstration Project is a Government funded study to better understand the practical feasibility of large scale retrofit of heat pumps into existing UK homes. Heat pumps were installed in 742 properties by three delivery contractors. The study examined the survey, design and installation process and is monitoring the performance of the heat pumps after installation. The study includes reports on the installation work and an interim report on operational performance of the heat pumps up to August 2022. Further performance monitoring is ongoing and a final performance report will be published after September 2023.

Heat pumps were installed across the range of typical UK property types, ages and sizes. The breakdown of the 742 installations by property age, type, size and Energy Performance Certificate (EPC) rating is shown below.

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|  | NB: not all properties had EPC certificates. |

The heat pumps installed were primarily ASHPs: 41% were low temperature ASHPs; and 33% were high temperature ASHPs i.e. ASHPs capable of providing heat at over 65°C flow temperature (equivalent to a condensing boiler). ASHPs installed ranged from 5 kW to 16 kW in capacity, the most common size was 8.4 kW. Only 5% of properties had Ground Source Heat Pumps installed. In almost all cases (93%) new, larger radiators were installed in addition to the heat pumps, however only a minority of properties (15%) had insulation upgrades (mostly loft insulation) at the same time. Average installation costs were £14,800, inclusive of radiator upgrade costs. Installations typically took 2-4 days and involved 2 installers and 1 electrician.

Whenever a heat pump is installed the local electricity Distribution Network Operator (DNO) needs to be notified. If the maximum current demand after installation is predicted to exceed 60 Amps DNO approval is required for the installation. If the maximum demand is lower than 60 Amps the DNO can simply be notified after installation (within 28 days). Where DNO approval was required, the Electrification of Heat project found that this took up to 11 weeks in many cases. DNOs are, however, reported to have made improvements to speed up their processes since the study took place.

The Seasonal Performance Factor (SPF) of a heat pump is the ratio of kWh heat it delivers to kWh electricity it consumes over a year. This is an indication of the operational efficiency of the heat pump, higher SPFs representing better performance. Median SPFs for the ASHPs installed was 2.80. This includes electricity consumed by any backup or immersion heaters included in the systems. Interestingly there was no significant difference in SPF across the range of property ages (Median SPF for the pre-1919 properties was actually slightly higher at 2.94). SPF was higher for systems where a lower flow temperature was set, however, SPFs for low temperature and high temperature ASHPs were 2.74 and 2.89 respectively. The counter-intuitively higher SPF for the high temperature heat pumps is “*likely due to a combination of higher performing refrigerants and weather compensation controls meaning that they operate at lower temperatures most of the time”*. SPFs were around 0.3 higher than those found in a study (*Final report on analysis of Heat Pump Data from the Renewable Heat Premium Payment scheme*) published in early 2017, suggesting that there have been significant improvements in the performance of heat pump installations over the past 5-6 years.

In the majority of cases ASHP installations complied with noise requirements specified in MCS standards and permitted development rights with no special measures. Noise enclosures or barriers were only necessary on 4% of installations. Almost half of the heat pumps installed were low noise models.

Some properties (12% of those surveyed) were deemed unsuitable for retrofit in this study for a variety of reasons. 7% required heat pumps larger than the largest units (18 kW) available to the study, 4% were excluded on thermal comfort grounds and 4% were deemed to be unaffordable. Some were excluded due to lack of external space (8%) for an ASHP, or available space being too close to neighbours (5%) or due to lack of internal space for a hot water cylinder (2%). Properties with microbore (<15mm diameter) pipework in their central heating were also noted as unsuitable without full replacement of pipework.

The study concludes that ASHPs are suitable not only for the most modern and energy efficient homes, but can be installed and operate efficiently in all typical UK property types, ages and sizes. In most cases heat emitter upgrades are required as part of the install. Insulation upgrades were not commonly required although will reduce heating demand and therefore running costs.

Are solid-wall properties suitable for ASHPs?

The project reports doesn’t explicitly discuss building construction methods. However, a full database of properties surveyed and installations has been published alongside the reports. This does record the building construction methods. In total there were 62 solid-walled properties retrofitted with heat pumps, 24 of which had existing solid wall insulation, the remaining 38 had no wall insulation and solid wall insulation was not fitted as part of the ASHP installations. Installation contractors triaged 50 solid wall properties out of the programme for technical reasons, 9 of these were due to concerns over whether the ASHP would achieve thermal comfort, 21 were due to large enough ASHPs not being available to the programme, the remainder were due to noise, space or cost constraints. The proportion of solid wall properties triaged out due to technical feasibility reasons was 31%. This compares to a 16% rate across properties of all construction types. This suggests installation of ASHPs in solid wall properties is more technically challenging than average. However, ASHP installation was feasible on solid wall properties in the majority of cases.

What do the findings mean for running costs and carbon emissions?

The project reports don’t directly discuss running costs, but energy bill costs relative to a gas boiler can be calculated from the Seasonal Performance Figure findings. The median SPF of 2.80 means that on average heat pumps are supplying 2.80 kWh of heat for each kWh of electricity they consume. In comparison an average boiler supplies around 0.8 kWh of heat for each kWh of gas it consumes[[1]](#footnote-1). Using these, plus gas and electricity prices we can calculate comparative costs per kWh of heat supplied. The comparison below uses the Government’s Energy Price Guarantee capped prices that apply from 1st July 2023 (30.11 p/kWh for electricity and 7.51 p/kWh for gas), but you can recalculate using your own current prices:

$ASHP cost per kWh\_{heat}=\frac{electricity price}{SPF}$ $Gas boiler cost per kWh\_{heat}=\frac{gas price}{boiler efficiency}$

$ASHP cost per kWh\_{heat}=\frac{30.11}{2.80}$ $Gas boiler cost per kWh\_{heat}=\frac{7.51}{0.8}$

$ASHP cost per kWh\_{heat}=10.75 p$ $Gas boiler cost per kWh\_{heat}=9.4 p$

So, in this comparison, an ASHP installation looks around 15% more costly to run on average than an average gas boiler. This is an annual average, as SPF is calculated from heat supplied and electricity consumed across the year as a whole. The ASHP is likely to be slightly more costly than this in winter when air temperatures are low and less costly in spring and summer when air temperatures are higher. If you are dispensing with gas for cooking and have your gas supply disconnected, you will save on standing charges for gas as well. Government has recognised that the policy costs included in electricity (but not in gas prices) prices make heat pumps less attractive, which is why it accepted recommendations in its March 2023 Powering Up Britain publication to “rebalance” prices between gas and electricity.

Comparisons with the costs of running an oil boiler can be made by the same calculations, using an oil price instead of a gas price. The only additional step required is to convert an oil price from pence per litre to pence per kWh. There are 10.3 kWh of energy in a litre of oil. Oil prices are highly volatile, the following calculation, based on average oil price of 77 p/litre over the past 12 months is given for illustrative purposes. At this oil price, oil and gas heating costs are almost identical.

$$Oil price per kWh=\frac{price per litre}{kWh per litre}$$

$$Oil price per kWh=\frac{77}{10.3}=7.5 p/kWh$$

$$Oil boiler cost per kWh\_{heat}=\frac{oil price per kWh}{boiler efficiency}$$

*Oil*$ boiler cost per kWh\_{heat}=\frac{7.5}{0.8}$

$$Oil boiler cost per kWh\_{heat}=9.3 p$$

Carbon savings from heat pumps relative to gas boilers can also be calculated from the median SPF and average gas boiler efficiency. This time you will need to use the carbon intensity of gas and electricity. These are 182.5 gCO2e/kWh for gas and 193.4 g/kWh for electricity (2022 grid average).

$ASHP gCO2e per kWh\_{heat}=\frac{carbon intensity of electricity}{SPF}$ $Gas boiler gCO2e per kWh\_{heat}=\frac{carbon intensity of gas}{boiler efficiency}$

$ASHP gCO2e per kWh\_{heat}=\frac{193.4}{2.80}$ $Gas boiler gCO2e per kWh\_{heat}=\frac{182.5}{0.8}$

$ASHP gCO2e per kWh\_{heat}=69 g/kWh$ $Gas boiler gCO2e per kWh\_{heat}=228 g/kWh$

So, an average ASHP installation reduces carbon emissions from heating by 70%. The electricity grid is decarbonising year on year so the saving will increase over time.

Further information

The study and the full reports are available at: <https://es.catapult.org.uk/project/electrification-of-heat-demonstration/>

The full database of survey and installation data is available at: : <https://usmart.io/org/esc/discovery/discovery-view-detail/5325ef18-9cd1-493c-beae-e278d8998400>

Energy Price Guarantee capped prices are reported here: <https://www.moneysavingexpert.com/utilities/energy-price-guarantee-need-to-knows/>

Gas boiler operational efficiencies from trials are reported at: <https://www.theheatinghub.co.uk/are-we-being-mislead-over-boiler-efficiencies-erp-sedbuk>

The Powering Up Britain strategy is here: <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1147340/powering-up-britain-joint-overview.pdf>

Carbon emissions intensity figures for gas and electricity are here: <https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2022>

1. Central boiler operational efficiency as reported at: <https://www.theheatinghub.co.uk/are-we-being-mislead-over-boiler-efficiencies-erp-sedbuk> [↑](#footnote-ref-1)